Data Driven Approaches To Optimizing Building Energy Performance

Knowing is half the battle: How emerging energy information systems can drive and verify savings

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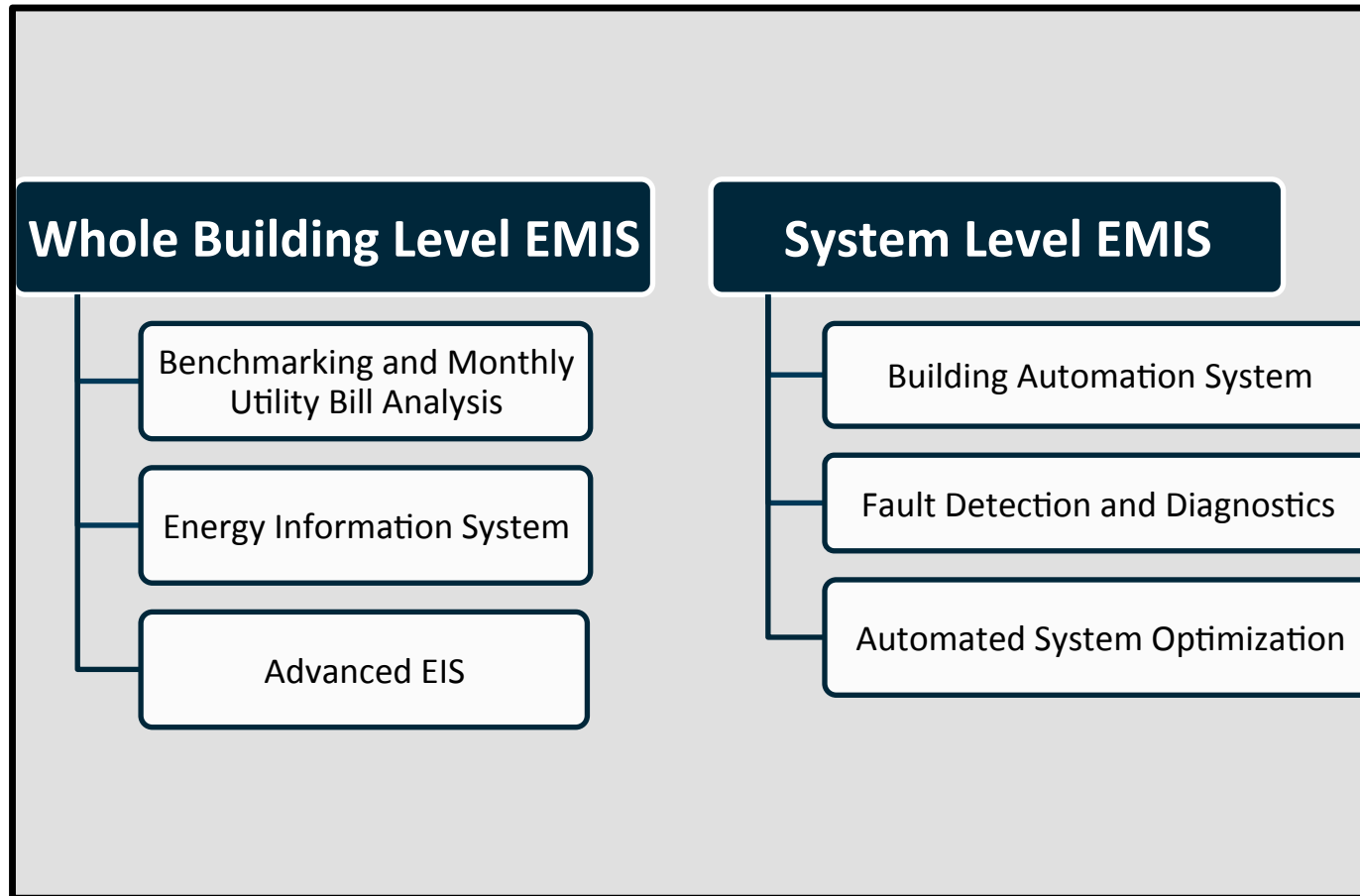
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Outline

- Landscape of commercial tools to optimize operational energy performance – commercial buildings

- Costs and benefits of energy information systems

- Savings verification

- Closing thoughts

- Short Q&A

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Landscape of Commercial Tools

Energy Management and Information Systems

| Whole Building Level EMIS	System Level EMIS
Benchmarking and Monthly Utility Bill Analysis	Building Automation System
Energy Information System	Fault Detection and Diagnostics
Advanced EIS	Automated System Optimization

* The boundaries can be fuzzy; some tools cross categories, e.g., energy information systems with FDD and benchmarking capabilities

EMIS Examples
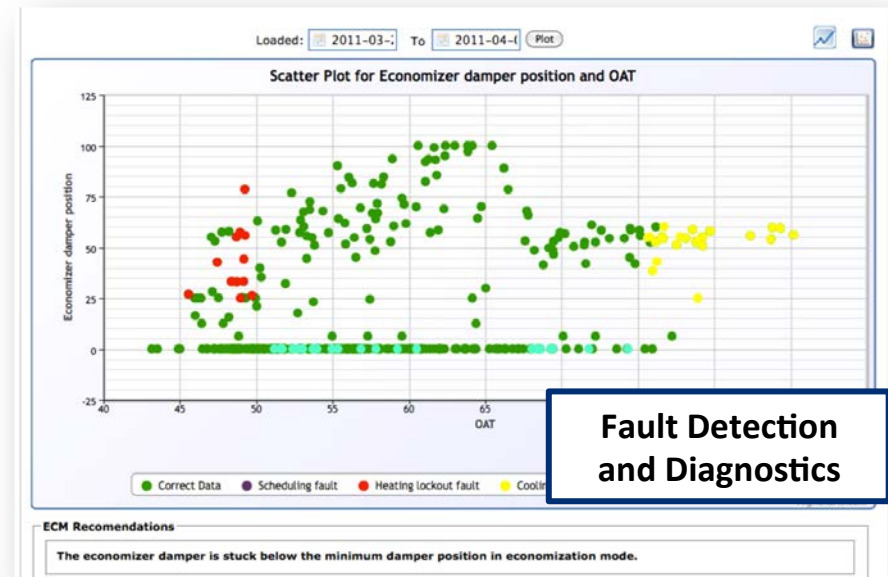

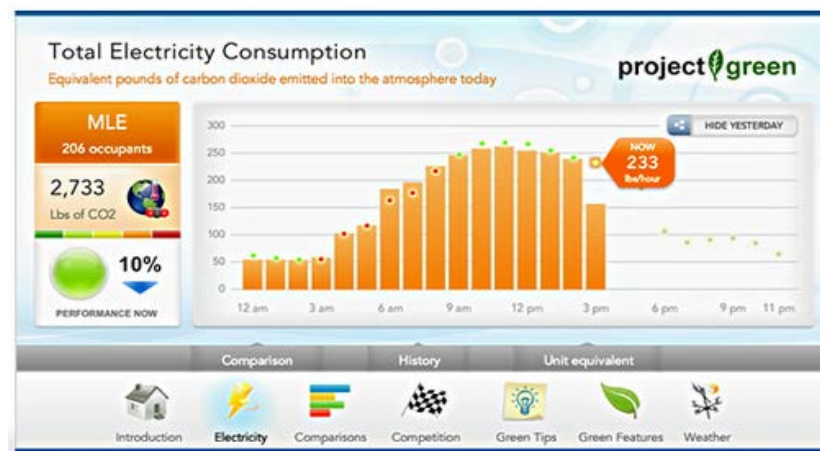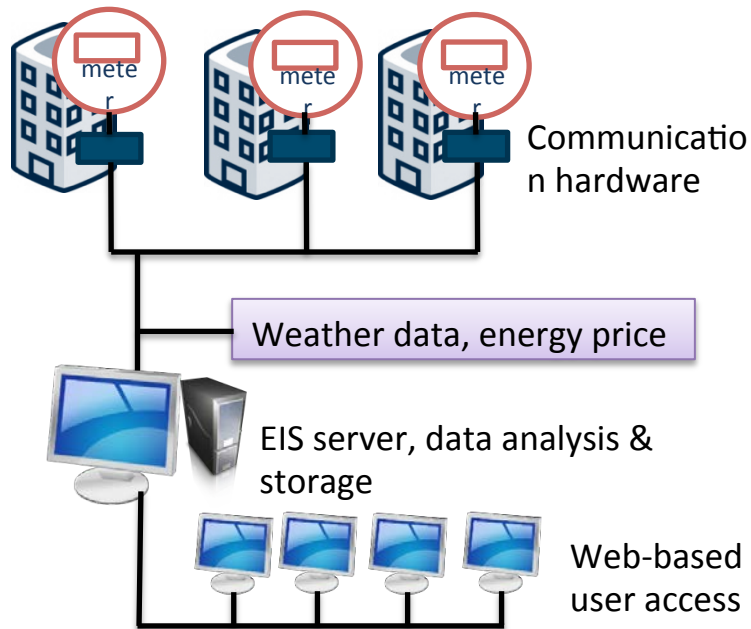**Benchmarking and Monthly Utility Bill Analysis**
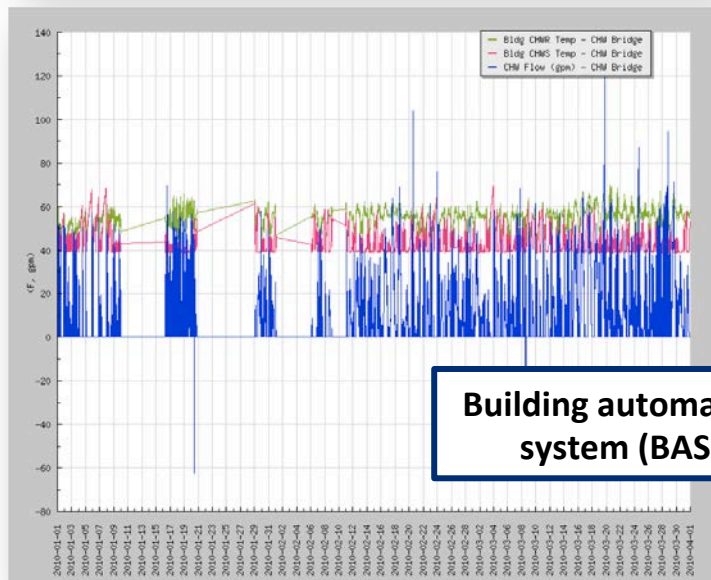
Fault Detection and Diagnostics

Building automation system (BAS)

Energy Information Systems (EIS)

Hourly to **15-min** interval meter data

meter
meter
meter

Communication hardware

Weather data, energy price

EIS server, data analysis & storage

Web-based user access
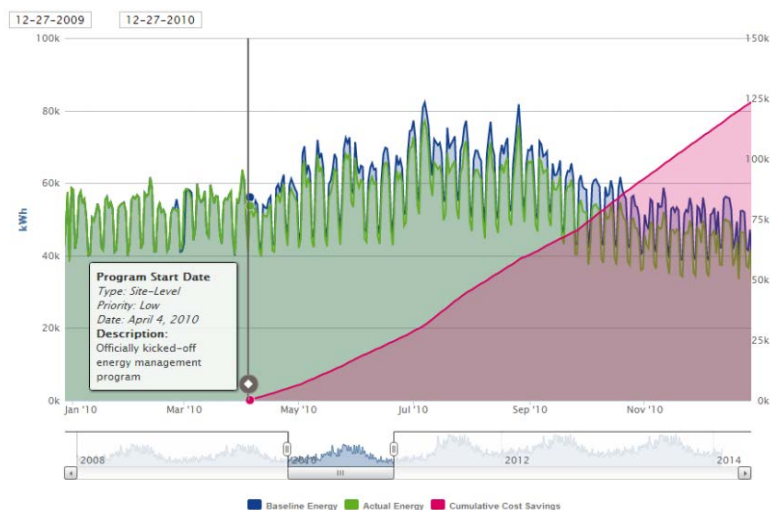
Images: Lucid (top); Sensei (bottom)

What is Compelling About EIS?

- Optimal energy performance cannot be achieved or maintained purely through the use of monthly utility bills

- Continuous visualization and analysis of interval meter data enables
  - Site energy savings up to 20% through *operational* measures
  - Persistence in efficient performance

- EIS (and related EMIS tools) are beginning to offer automated measurement and verification capability

- The same technology that drives the savings can be used to verify the savings

Costs and Benefits of Energy Information Systems

Value Proposition, Business Case for Adoption

- Although the market offers *many* commercial offerings, and experience is increasing
  - These information technologies are not yet widely adopted throughout the commercial stock

- What are users really saving, and what are they paying for these tools?
  - One of largest barriers to adoption has been inability to make business case
  - Save 0-20%, cost $5K- ???

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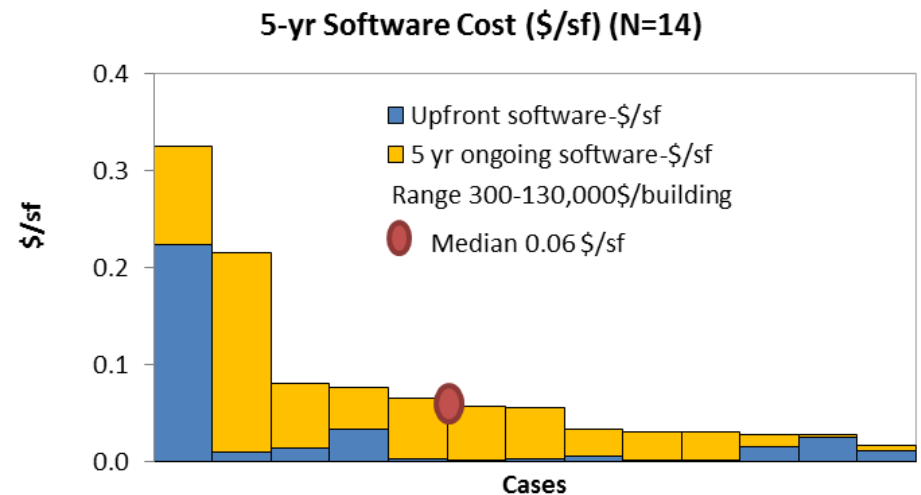
Costs and Benefits of EIS Use in Large Portfolios
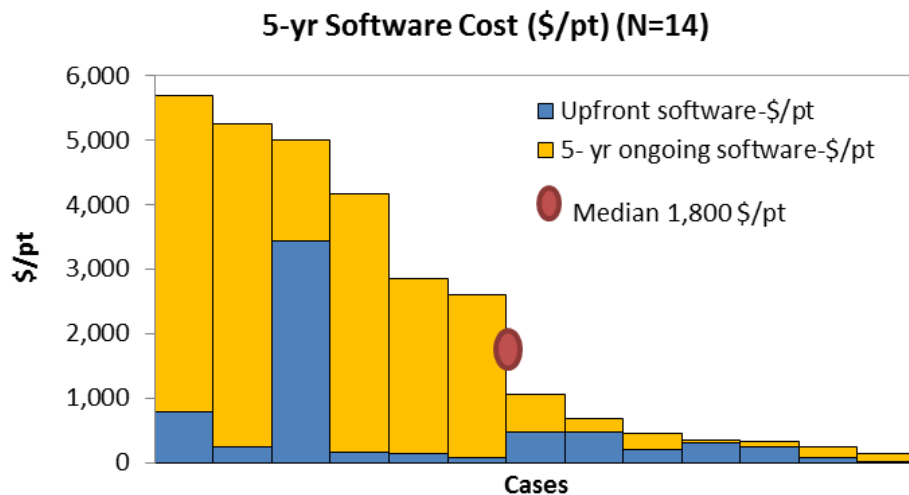
Synthesized case investigations to identify as-implemented costs, over-time energy savings, best practices, factors associated with larger savings

26 participating organizations, 260M sf install base, 17 unique EIS

EIS Costs Reported by Study Participants

Median 5-yr cost of ownership = $150K, 1800$/pt, .06$/sf

5-yr Software Cost ($/pt) (N=14)

Legend:
- Upfront software-$/pt (blue)
- 5- yr ongoing software-$/pt (yellow)
- Median 1,800 $/pt (red oval)

Not plotted but included in the calculation of median:16,000

5-yr Software Cost ($/sf) (N=14)

Legend:
- Upfront software-$/sf (blue)
- 5 yr ongoing software-$/sf (yellow)
- Range 300-130,000$/building
- Median 0.06 $/sf (red oval)

Not plotted but included in the calculation of median: 1.1

- Note the wide distribution of costs paid by study participants
- Some economies of scale with size of implementation

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Savings: Year Prior to EIS Installation vs. Most Recent Year of Data

- Median building and portfolio savings of 17% and 8% would not be possible without use of the EIS
  - Median building and portfolio utility savings of $56K, and $1.3M

- Key benefits
  - **Operational efficiency**, utility validation and payment, data for other analyses
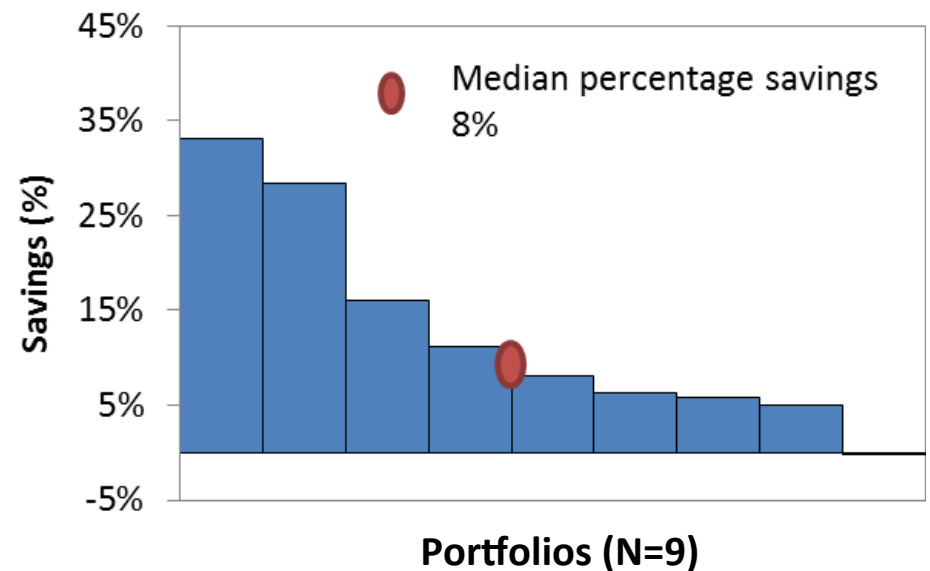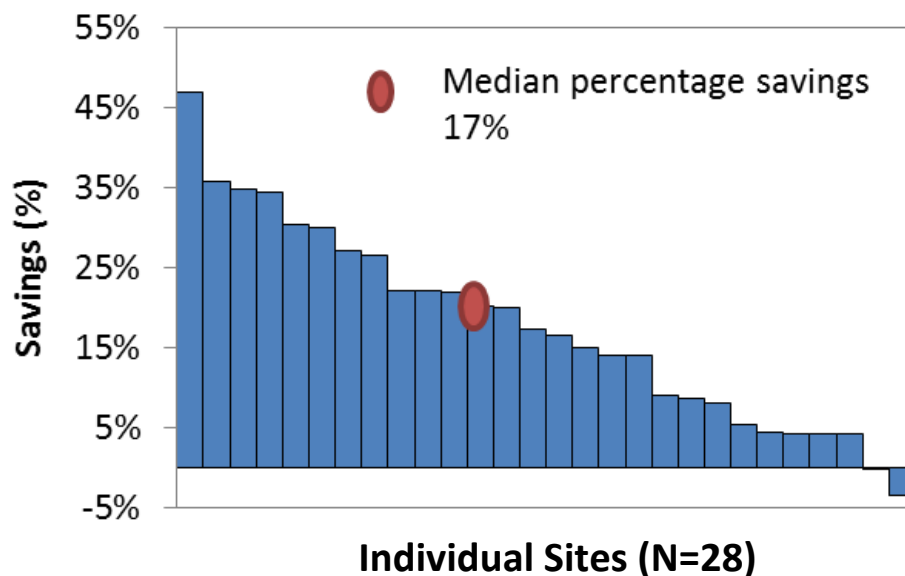
Key Factors and Best Practices

- Initial EUI, extent of efficiency projects, depth of metering, and total years of installation correlated with higher savings
    - EIS rarely if ever implemented as sole strategy
    - All but two participants reported savings could not have been achieved without the EIS
    - Those with less aggressive efficiency projects still saved 5%

- Best practices
    - Installation of submetering, beyond whole-building level
    - Load profiling on a regular basis
    - Use of automated energy anomaly detection features
    - Monitoring peak load and managing demand charges
    - With regular usage over time, savings can accrue and deepen

13
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Savings Verification

Savings Verification

Automated M&V is beginning to be offered in energy management and information systems

Baselines are automatically created using historic interval meter data (system level or whole-building) and weather data feeds

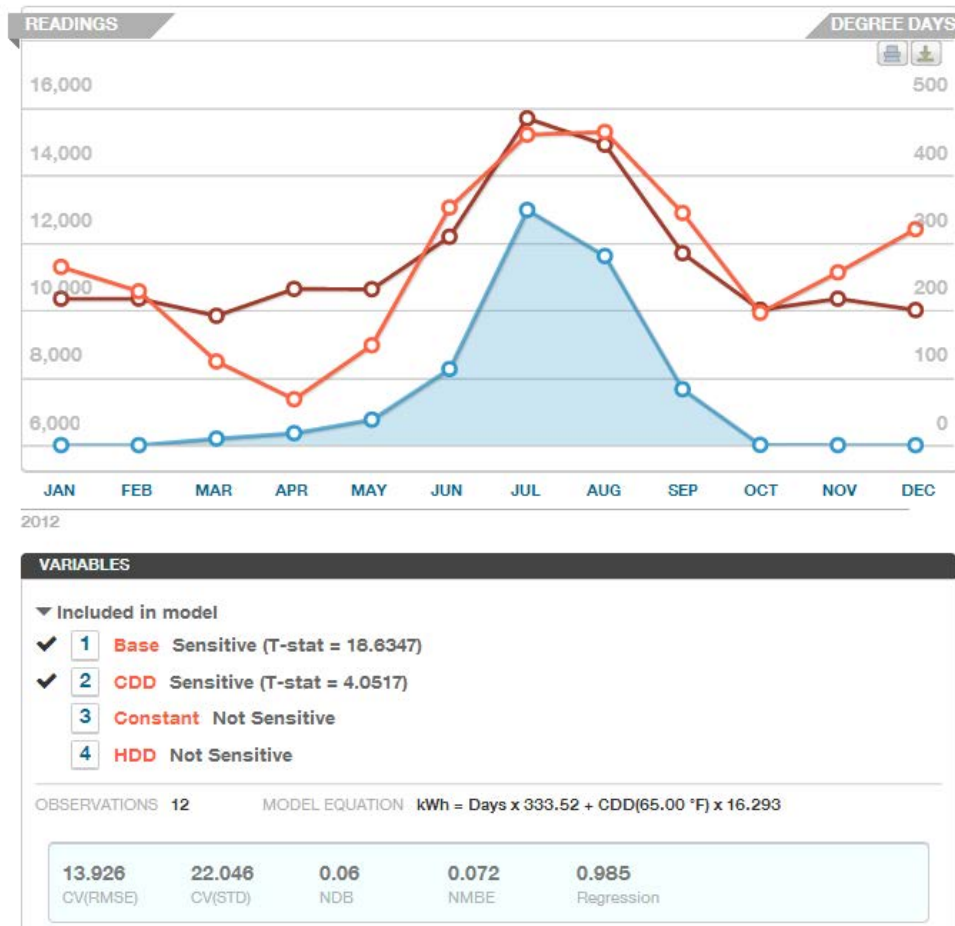Regression, NN, Bin models most common

User enters the date of ECM implementation, savings automatically calculated

M&V Use Case
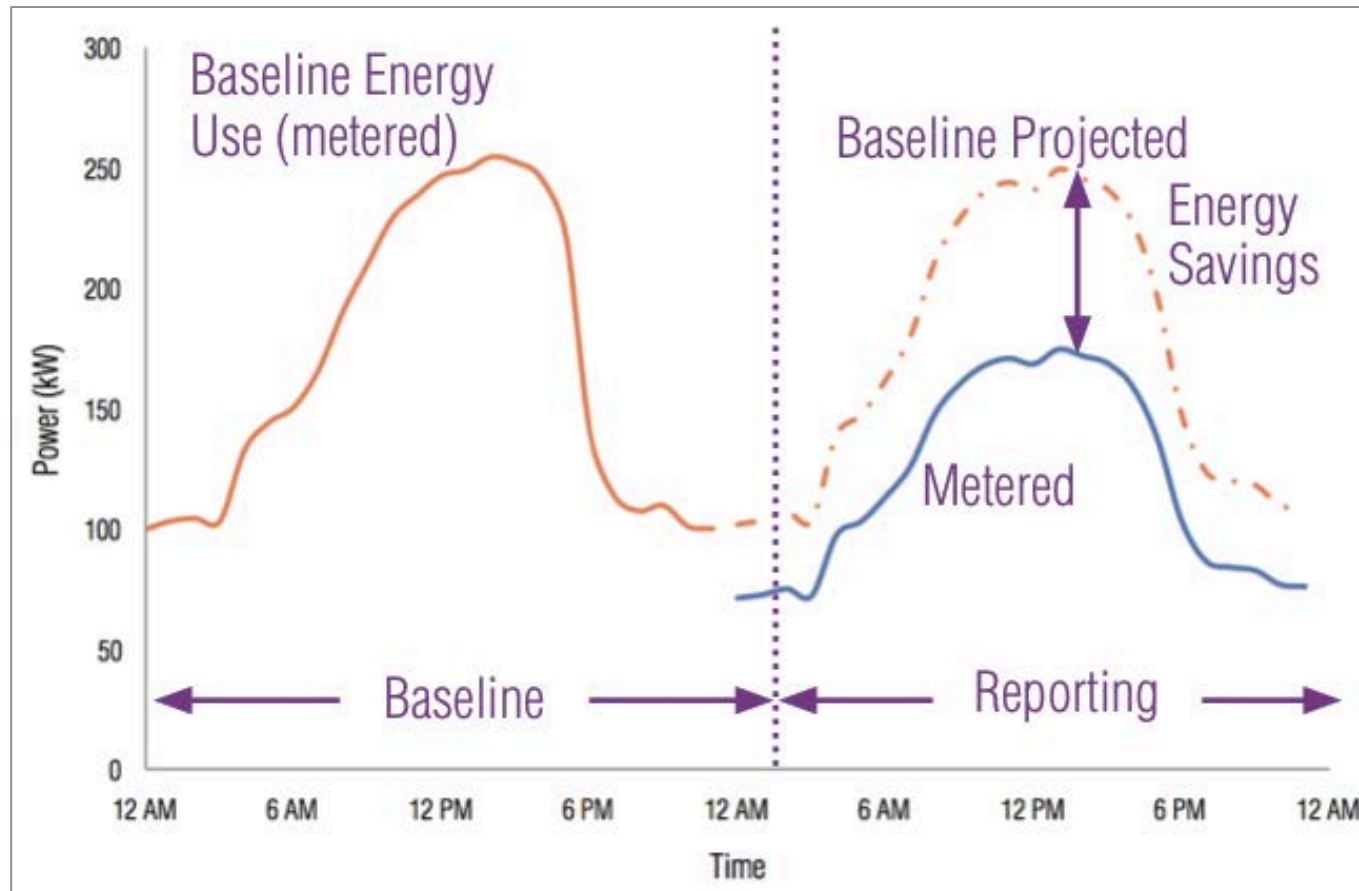
Automated M&V May Use Interval, Daily, Monthly Data
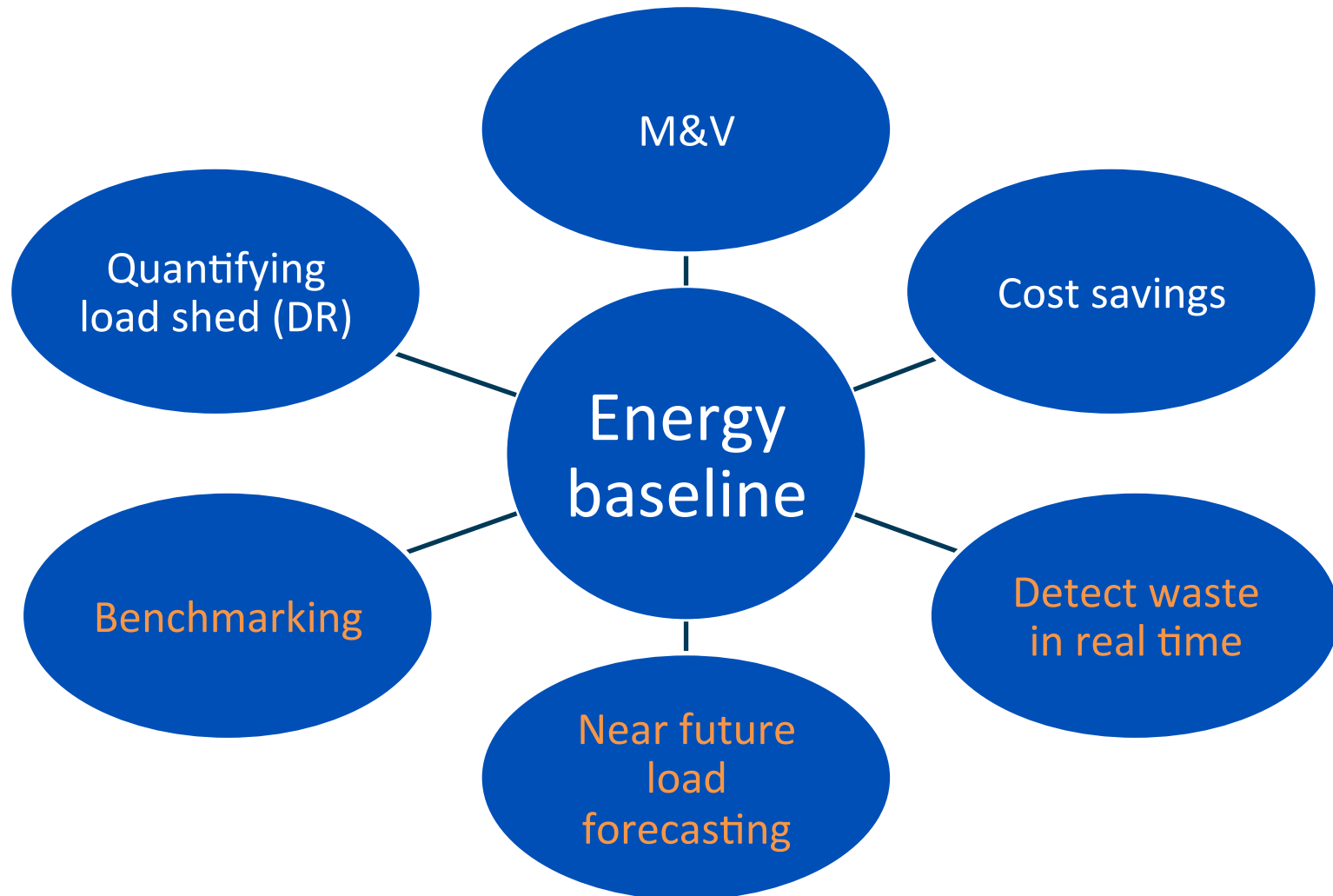

Example at left from Noesis Energy

While this example uses monthly data; interval data offers the most promise

What Questions Are Being Asked?

- How can I determine whether a given model or commercial tool is robust and accurate?

- How can I compare and contrast proprietary tools and 'open' modeling methods for M&V?

- How can we reduce the time and costs necessary to quantify savings?

- What repeatable test procedures can be used to evaluate model and tool performance, and which metrics provide critical performance insights?

- Can I use a whole-building approach for my programs and projects?

*See current LBNL research at eis.lbl.gov

The Energy Baselines in EMIS Serve Many Purposes

Central: Energy baseline

- M&V
- Cost savings
- Detect waste in real time
- Near future load forecasting
- Benchmarking
- Quantifying load shed (DR)

Closing Thoughts

- Growing availability of intelligent analytics tools, and metered building energy data present a tremendous opportunity for our industry
  - Leading edge adopters are making powerful use of the technology

- The same technologies that drive significant savings also promises the ability to verify those savings
  - A win for the scaled adoption of cost-effective energy efficiency
  - Transparency and evidence that savings are achieved, value is delivered
  - Persistence of savings through continuous data-driven energy management

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Questions?